CEREAL PREFERENCE AND INTAKE OF FOUR SPECIES OF FIELD RODENTS[1]

SHAKUNTHALA SRIDHARA[2] AND R. V. KRISHNAMOORTHY

(*With a text-figure*)

The preference and intake of different grains and standard rat and mice feed and the effect of texture were assessed in four species of rodents namely *Bandicota bengalensis bengalensis* Gray, *Rattus rattus* Linn, *Rattus meltada* Gray and *Tatera indica cuvieri* Waterhouse. The calorific and nutritional value of the food, effect of habitat, activity of the animal, body weight and palatability of the grain offered all affected preference and consumption. These studies suggest that for wetlands and residential area a bait composed of rice-ragi should be used for control by poisoning and for drylands a jowar-maize bait would be more acceptable.

INTRODUCTION

Although some field and laboratory studies on food selection and preference of rodents have been conducted (Prasad, 1954; Prakash, 1962; Parrack, 1969; Prakash *et al.*, 1970; Bindra & Sagar, 1976 Jain *et al.*, 1974; Prakash *et al.*, 1974; Khan 1974) more information is needed for a variety of species. Such studies would be of great help in formulating bait composition for field control. The present investigation therefore examined the feeding preferences of *Bandicota bengalensis bengalensis* Gray, *Rattus rattus* Linn. *Tatera indica cuvieri* Waterhouse and *Rattus meltada* Gray. Preferences for different cereals and the effect of texture of grain on preference were assessed.

METHODS

Adult lesser bandicoots (6 ♂♂ and 6 ♀♀) were trapped in paddy fields; soft-furred field rats and gerbils (3 ♂♂ and 3 ♀♀ of each) were captured in cultivated ragi fields. Black rats (5 ♂♂ and 5 ♀♀) were trapped in the residential area near the University campus. All the rats were housed individually in metal cages. Each cage was provided with cotton wool and hay for bedding. Photoperiod was regulated at 12 hours light and 12 hours darkness with the light period starting at 06-00 hrs. Air temperature varied at 23±2°C.

Cereal preference: The cereals were offered in a socket-cylinder type of container. The inner component was a cylinder with 8 cm diameter, 4.5 cm in height with a 4.4 cm circular opening in the centre. The inner container fitted into the outer component which was fixed to the floor of the cage. The devise greatly reduced spillage of grain.

'No choice experiment': Consumption of locally grown rice (*Oryza sativa*), ragi (*Eleusine coracana*), wheat (*Triticum aestivum*), jowar (*Sorghum vulgare*) and maize (*Zea-mays*) were tested in that order, each cereal for seven consecutive days. Similarly the rate of consumption of standard rat and mice feed (Hindustan Lever, India) was estimated and compared with cereal intake. Water with added 2% multivitamins (Multivitamin syrup,

[1] Accepted January 1977.

[2] Departments of Vertebrate Biology and Zoology University of Agricultural Sciences, G.K.V.K. Campus, Yelahanka Post, Bangalore North 562 142.

Glaxo Laboratories Pvt. Ltd., India) was always available. Food consumption was expressed as g/100 g body weight/24 hrs. and its calorific equivalent.

Paired choice experiment: Rice was paired with ragi, wheat, jowar and maize. For preference between two cereals, two separate containers containing 40 g each of the cereals were placed in diagonally opposite corners of the cage. Consumption of each cereal was measured as before.

Texture choice: Each test grain was offered in three forms-as whole grain, broken grain and powder form in three different containers simultaneously and the preference towards texture studied.

Activity scores: The rats of each species were observed for ten minutes each day individually for five days at 10 A.M. to overcome the effect of diurnal rhythms. During the ten minute counts of sniffing, drinking water, eating, exploring the cage, climbing and running were recorded.

TABLE 2

RATE OF COMMERCIAL FEED CONSUMPTION AND ITS CALORIFIC EQUIVALENT IN FOUR SPECIES OF WILD RODENTS

Species	Pellets consumed g/100g body weight	Calorific equivalent of consumed pellets	Body weight (Range)
B. bengalensis	12±1.8	38.4	250–300
R. rattus	10±0.9	32.0	150–200
T. indica	11±1.6	35,0	130–150
R. meltada	10±1.5	32	70–100

Values are mean of the means of each week observations ± S.E.

TABLE 1

INTAKE OF DIFFERENT CEREALS BY FOUR SPECIES OF RODENTS

(*B. bengalensis, R. rattus, T. indica* AND *R. meltada*)

Species	RICE g/100g cal		RAGI g/100g cal		WHEAT g/100g cal		JOWAR g/100g cal		MAIZE g/100g cal		Mean grain intake	Mean cal. intake
B. bengalensis	6±1	21±4	5±0.5	17±2	5±0.5	17±2	4.8±1	17±3	4.5±0.3	15±3	5±0.2	18±1
R. rattus	12±0.8	41±3	11±0.8	35±3	9±0.4	31±2	7±0.6	24±2	11±1	38±3	10±0.8	34±2
T. rndica	14±1	48±3	18±6	59±5	12±1.8	41±6	16±1.5	56±5	21±4	73±1	16±1.5	55±7
R. meltada	8±1.5	28±5	16±0.8	53±3	14±1.8	48±6	12±1.7	42±5	16±2	55±6	13±1	45±4

$p > .001$

Values are mean of the means of each week of observations ± S.E.

Statistical analysis: Student's 't' test (Croxton 1953), Friedman's two-way analysis of varience by ranks and Krushkal-Wallis one way analysis of varience by ranks (Seigel 1956) were used to compare the preferential intake of cereals, the effect of texture on preference and activity scores respectively.

Results

B. bengalensis: In the absence of any choice the lesser bandicoot consumed more rice than each of the other cereals. Ragi and wheat were eaten more than jowar and maize (Table

Table 3

Intake of cereals by four species of rodents when paired choice of cereals was offered

	Rice	ragi	RICE vs. RAGI p	Preference	total cereal intake	total cal. intake
bengalensis	4,2±0.9	3.2±0.4	=0.2	rice & ragi	7.4	25
rattus	6.0±1.0	4.5±1.0	>0.2	rice & ragi	10.5	35
indica	1.5±0.5	9.5±2.0	>.01	ragi	11.0	37
meltada	2.5±0,5	7.5±0.8	>.01	ragi	10.0	33
			RICE vs. WHEAT			
bengalensis	4.0±0.7	1.8±0.5	>.001	rice	5.8	20
rattus	6.3±0.2	1.6±0.3	>,001	rice	7.8	28
indica	6·3±1.0	2.7±0.5	>.05	rice	9.0	31
meltada	6.0±1.0	3.0±0.8	>.05	rice	9.0	31
			RICE vs. JOWAR			
bengalensis	4.5±0.3	0.7±0.2	>.001	rice	522	19
rattus	5.7±1.0	5.5±0.2	>.1	rice & jowar	11.2	37
indica	4.2±0.5	7.7±1.3	>.05	jowar	12.0	42
meltada	4.5±1.0	6.5±0·5	>.05	jowar	11.0	38
			RICE vs. MAIZE			
bengalensis	4.0±0.6	0.8±0.3	>.001	rice	4.8	16
rattus	7.4±0.6	0,6±0.5	>.001	rice	8.0	28
indica	5.0±0.5	3.5±0.8	>.05	rice	8.5	30
meltada	6.5±1.0	2.5±1.0	>.02	rice	8.0	31

Readings are the mean of means of 7 observations ± S.E.

1). Bandicoots however, ate less grain than commercial feed (Table 2). In paired choices they preferred rice and ragi than wheat, maize and jowar (table 3). Rice was prefered to all other grains except ragi. No preferential order was noticed. Similar results were reported by Spillett (1968) for lesser bandicoots. Rice-ragi combination was highly consumed (Table 3). The grain consumption was higher when more than one grain was present (Table 1 and 3). Bindra & Sagar (1970) observed the same trend in lesser bandicoots. Grain in powder form was preferred to broken or whole grains (Table 4).

Lesser bandicoots registered the lowest level of physical activity (Table 5).

R. rattus: Black rats ate more rice, ragi and maize than wheat and jowar when there was no choice (Table 1). Compared to lesser bandicoots, they consume less commercial feed (Table 2), but twice as much grain (Table 1). When a choice was offered they prefered rice followed by ragi and jowar, wheat and maize (Table 3). Earlier black rat's preference towards rice when offered along with four other food stuffs was observed by Harrison & Woodville (1950). The rate of intake was not affected by the presence of more than one grain (Table 3). Krishnamurthy *et al.* (1967) noticed similar trend in black rats. Rice and jowar combination was liked more than any other pair of cereals (Table 3). Powdered grain was prefered to broken or whole grain (Table 4).

Activity scores were higher than that of

TABLE 4

EFFECT OF CEREAL TEXTURE ON CONSUMPTION RATES OF WILD RODENTS

		RICE	RAGI	WHEAT	JOWAR	MAIZE
B. bengalensis	a.	0.9±0.1	0.0	0.4±0.3	0.3±0.1	0.3±0.2
	b.	3.6±0.5	0.8±0.1	1.7±0.3	1.3±0.3	1.9±0.5
	c.	3.9±0.8	7.0±1.4	4.9±0.3	6.5±0.5	4.4±0.4
	d.	8.4±0.7	7.8±1.5	7.1±0.6	8.1±0.5	6.7±0.6
R. rattus	a.	2·3±0.5	0.0	0.7±0.6	2.3±0.8	0.5±0.2
	b.	1.9±0.6	2.7±0.5	0.6±0.1	0.5±0.2	0.2±0.04
	c.	5.5±1.2	9.0±0.5	8.0±0.7	9.5±0.6	3.8±2.0
	d.	9.7±1.0	12±0.9	9.3±0.8	12.2±1.2	4.5±1.5
T. indica	a.	1.5±0.02	0.0	5.0±0.6	4.0±0.7	3.1±1.0
	b.	0.8±0.3	6.9±1.0	3.0±0.6	3.0±0.4	0.7±0.3
	c.	7.3±0.2	4.3±1.0	9.0±0.7	7.0±0.6	8.1±1.3
	d.	9.6±0.2	11.8±0.8	17.0±0.6	14.0±1.0	12.0±1.4
R. meltada	a.	2.0±0.3	0.0	0.8±0.3	1.8±0.5	0.6±0.1
	b.	1.5±0.2	1.9±0.4	2.2±0.4	0.9±0.3	2.2±0.5
	c.	5.9±0.5	8.5±0.3	6.0±2.0	9.2±0.5	4.2±0.5
	d.	9.4±0.5	10.4±0.4	8.8±1.5	11.9±0.6	7.0±2.0
		p>.0046	p>.0046	p>.0046	p>.0046	p>.0046

Values are mean of the means of 7 observations ± S.E.

a, whole grain; *b*, broken grain; *c*, powder form of the grain; *d*, total consumption.

lesser bandicoots but below that of gerbils (Table 5).

T. indica: Gerbils ate more maize than any of the other grains (Table 1) when there was no choice. The order of intake was maize > ragi > jowar > rice > wheat. Next to lesser bandicoots, they consume the highest amount of commercial feed (Table 2). Mean grain consumption was highest in gerbils (Table 1).

When faced with a paired choice the decreasing order of preference was: ragi-jowar; rice; wheat-maize (Table 3). Rate of consumption was more when there was no choice (Tables 1 and 3) in contrast to earlier studies of Bindra & Sagar (1970). Rice and jowar combination was the most preferred pair (Table 3).

Powdered grain was the most liked but the extent of preference towards whole grain was more in gerbils than in other species tested (Table 4).

Highest physical activity was seen in gerbils (Table 5).

R. meltada: The soft-furred field rats preferred all the grains except rice (Table 1). When offered a paired choice, preference for ragi and jowar was seen followed by rice, maize and wheat (Table 3). Rate of consumption was more when there was no choice (Table 1 and 3) .Earlier it was reported that single or multiple choice had no effect on average daily intake of food (Jain *et al.* 1974). Rice and jowar combination was the best liked (Table 3). Powder form was preferred to other forms of grain offered (Table 4).

Activity scores were similar to black rats (Table 5).

Calorific intake: The data presented in fig. 1 illustrates that gerbils consume more calories than other species followed by *R. meltada*, *R. rattus* and *B. bengalensis*.

TABLE 5

ACTIVITY SCORES OF WILD RODENTS UNDER CAPTIVE CONDITIONS

Species	Activity scores
B. bengalensis	15±3
R. rattus	26±3
T. indica	35±5
R. meltada	25±3

>.001

Values are mean of the means of observations ± S.E.

DISCUSSION

Though most rodents are omnivorous and versatile feeders, different species exhibit subtle differences in their food preferences (Landry 1970; Barnett 1966). Exploratory capacity and learning behaviour help rats adapt themselves to changing situations (Barnett 1975). However, factors which influence the food selection and food detection are not well known.

Food preference may be affected by the nutritive value of the food. Since the calorific values of the foods offered in the present experiment ranged from 3.2 to 3.6 calories per gram (Aykroyd 1976), the influence of the calorific value of the food on preferential intake was probably negligible. *B. bengalensis* consumed twice as much commercial feed as cereals though the calorific values are about equal. Probably the commercial feed was more palatable, nutritive or more easily eaten.

Food preference is also affected by the earlier experience of the animal (Forgus & Hutchings 1960); such an effect was not

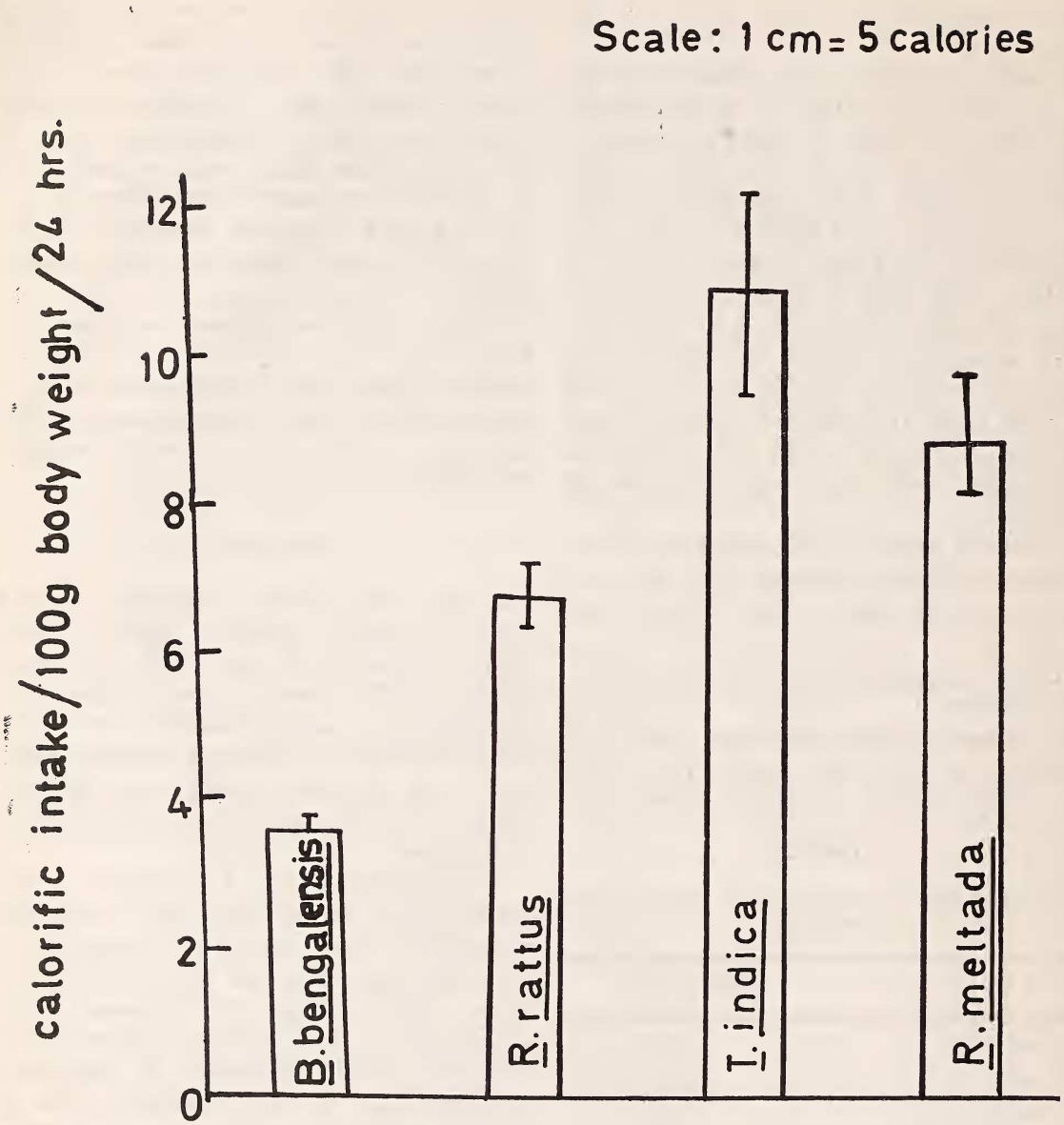

Fig. 1. Average calorific intake in field rodents.

however found by Bronson (1966) or Krishna Kumari (1973). But Barnett (1966) suggests that given a choice rats tend to select the food with which they are most familiar. *B. bengalensis* inhabits clay loam soils and wet paddy fields (Srivastava *et al.* 1968; Urs *et al.* 1968; Sridhara 1976) where rice is readily available; thus their preference for rice and ragi in the laboratory. In case of *R. rattus,* its preference for rice may again result from its earlier experience of that food since rice was the staple food of people in the area from which the black rats were captured. Their liking for ragi and jowar may be due to the small size and smooth consistency of these grains (Khan 1974). Both *T. indica* and *R. meltada* inhabit a wide variety of dryland habitats (Urs *et al.* 1968; Chandrahas & Krishnaswamy 1974) and in the present study were collected from ragi fields; hence their preference for dryland crops.

Food consumption is also influenced by the physical activity of the animal. Laboratory observations showed gerbils as the most active rodents followed by *Rattus* genera and bandicoots. Comparison of average grain intake (Table 1) and calorific intake (Figure 1) shows that a correlation can be drawn between the two.

Food consumption is related to bodyweight; food eaten per gram of body weight declines however with increasing body weight (Barnett 1975). Thus energy requirements of the animals are generally inversely proportional to body weight and calorific intake is greater in animals of low weight (*R. meltada* and *T. indica*) than in *B. bengalensis* (Table 2).

Texture preferences are purely due to palatability reasons since rats often prefer soft or finely divided food to hard or coarse grain (Barnett & Spencer 1953; Jain *et al.* 1974; Prakash *et al.* 1974). All the four species studied confirmed this (Table 4).

Rodents are characterised by 'Omnivory' and 'Sampling' of all available food in their environment (Barnett 1975). All the four species always sampled all available foods but in quantities related to nutritive values of the food, palatability, earlier food experience, physical activity and body weight.

Basing on present results it can be suggested that a bait of rice and ragi should be most effective for control of *B. bengalensis.* For the dryland species *R. meltada* and *T. indica* a jowar-maize bait and for the commensal black rat a rice-ragi or rice-jowar bait should be used.

Acknowledgements

We are indebted to Dr. K. Ramakrishnan, Dean, University of Agricultural Sciences, Bangalore for encouragement and Dr. R. Narayana, Director of Instruction (Basic Sciences & Humanities), University of Agricultural Sciences, Bangalore for offering facilities. Financial aid from the Ford Foundation (Grant No. 660-19B), New Delhi is gratefully acknowledged. Thanks are due to Dr. P. E. Cowan for critically going through the manuscript and for suggestions.

References

AYKROYD, W. R. (1976): The nutritive value of Indian foods and the planning of satisfactory diets. National Institute of Nutrition, Indian Council of Medical Research, Hydrabad, India.

BARNETT, S. A. (1966): The feeding of rodents. In: Indian Rodent Symposium. (Ed. K. L. Harris) New Delhi: 113-123.

———— (1975): The Rat: A Study in Behaviour. 2nd Edn. Chicago. University of Chicago Press.

———— AND SPENCER, M. M. (1953): Experiments on food preferences of wild rats (*Rattus norvegicus* Berkenhout). *J. Hyg. Camb. 51*:16-34.

BINDRA, O. S. AND SAGAR, P. (1970): On food preferences and rate of food consumption by three species of field rats. *Bull. Grain Tech. 8*:46-49.

BRONSON, G. (1966): Evidence of lack of influence of early diet on adult food preferences in rats. *J. Comp. Physiol. Psychol. 62*:162-164.

CHANDRAHAS, R. K. AND KRISHNASWAMI, A. K. (1973): Ecology of the soft-furred field rat, *Rattus meltada* (Gray) in Kolar, Mysore State. *J. Bombay nat. Hist. Soc. 70*:447-457.

CROXTON, F. E. (1953): Elementary Statistics with application in Medicine and Biological Sciences. Dover Publications Inc. New York.

FORGUS, R. H. AND HUTCHINGS, D. E. (1960): Effects of early experiences of flavour preference. *Psychol. Rep. 6*:410.

HARRISON, J. L. AND WOODVILLE, H. C. (1950): Notes on the feeding habits of house rats in Rangoon, Burma. *Annal. Applied Biol. 37*:296-304.

JAIN, A. P., PRAKASH, I. AND RANA, B. D. (1974): Baits for the control of soft-furred field rat, *Rattus meltada pallidior* Ryley. *Z. Angew. Zool. 61*:183-190.

KHAN, J. A. (1974): Laboratory experiments on the food preferences of the black rat, *Rattus rattus* Linn. *Zool. J. Lin. Soc. 54*:167-184.

KRISHNA KUMARI, M. K. (1973): Effects of early food experience on later food experiences in adult rats. *Pest Control*. Nov. 1973.

KRISHNAMURTHY, K., UNIYAL, V., SINGH, J. AND PINGALE, S. V. (1967): Studies on rodents and their control: I. Studies on rat population and losses of food grains. *Bull. Grain. Tech. 5*:147-153.

PRAKASH, I. (1962): Ecology of the gerbils of the Rajasthan Desert, India. *Mammalia. 26*:311-331.

————, FITZWATER, W. D. AND JAIN, A. P. (1970): Toxic chemicals and baits for the control of two gerbils, *Meriones hurrianae* Jerdon and *Tatera indica* Hardwicke. *J. Bombay nat. Hist. Soc. 66*:500-509.

————, JAIN, A. P. AND RANA, B. D. (1974): Baits for the control of the hairy-footed gerbil, *Gerbillus gleadowi. J. Angew. Zool. 61*:183-190.

PRASAD, M. R. N. (1954): Natural History of the South Indian gerbil, *Tatera indica cuvieri* (Waterhouse). *J. Bombay nat. Hist. Soc. 52*:184-189.

SIEGEL, S. (1956): Non-parametric Statistics. McGraw-Hill Kogakusha Ltd., Tokyo.

SRIDHARA, S. (1976): Burrow patterns of *Bandicota benghalensis bengalensis* Gray in the paddy fields of Karnataka. *Curr. Sci. 6*:207-209.

SRIVASTAVA, A. S., GUPTA, R. L., PANDEY, R. K., SINGH, B. D. N. AND MATHUR, K. P. (1968): Distribution of field rats in Kalyanpur Block, District Kanpur, India. In: International Symposium on Binomics and Control of Rodents. Kanpur, India.

URS, Y. L., KRISHNA KUMARI, M. K. AND MAJUMDAR, S. K. (1968): A report on the burrowing habit of rodents. In: Indian Rodent Symposium. (Ed. K. L. Harris). New Delhi: 199-203.